A New Methodology to Forecast Paleoclimate lime Series with Applications to the Southern Oscillation index

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Over the last four years, wc have developed a methodology based on adaptive prefiltering using singular spectrum analysis (S SA)--univariate (Keppenne & Ghil, JGR, 97, 1992; Keppenne & Ghil, *Nature*, 358, 1992, Keppenne, *J. Climate*, 8, 1995) or multivariate (Keppenne & Ghil, *Intl. J. Bifns. & Chaos*, **3**, 1993)—followed by the application of the maximum entropy method, to forecast noise-contaminated time series from deterministic dynamical systems. Univariate applications to forecast the Southern Oscillation index (S01) and multivariate applications to predict sea-surface temperature anomalies in the Niño-3 region have appeared regularly i o each issue of NOA A's *Experimental Long-1 ead Forecast Bulletin* (Keppenne & Ghil, 1993-1 995; Jiang, Neelin & Ghil, 1995).

More recently st i ll, I all & Sharma and 1 all, Sangoyomi & Abarbanel (Wafer *Resources Res.*, *in* press, 1995) have demonstrated the potential of advanced nonlinear time series algorithms to forecast nonstationary geophysical time series, with an applicat ion to predicting the bi-weekly volume changes of Utah's Great Salt Lake.

The present work combines the strengths of the two approaches: the application of SSA as an adaptive prefilter is followed by that of a "localized" variant of Friedman's (*Ann. Stat.*, 19, 1991) multivariate adaptive regression splines (MARS) algorithm to the prefiltered time series. The nonparametric, "localized" MARS is particularly suited to processing nonstationary signals from systems that can experience sudden changes in their dynamics such as, for example, abrupt shifts between glaciations and interglaciary episodes. The ncw methodology offers good promises for the analysis and prediction of paleoclimate time series. We first illustrate its potential with applications to "synthetic" noise-contaminated time series from nonlinear dynamical systems, prior to applying it to forecasts and hindcasts of the SOI.

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